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MORPHOLOGY OF DIAGNOSTIC STAGES OF INTESTINAL PARASITES

Dorothy M. Melvin, et al

National Communicable Disease Center
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June 1969

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MORPHOLOGY OF DIAGNOSTIC STAGES OF INTESTINAL PARASITES OF MAN

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D. M. Melvin, Ph.D.

Details of illustrations in this document may be better studied on microfiche.

June 1969

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
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PREFACE

Although the morphology of the diagnostic stages of the intestinal parasites found in man is described in many textbooks and manuals, it is not generally readily available in the average laboratory. The features commonly used for distinguishing species are tabulated and illustrated in this publication. Thus, the technologist doing parasitologic examinations in public health and medical laboratories can quickly refer to them. The booklet is designed to assist the microscopist in identifying the organisms found, but it is not a substitute for the practical training in laboratory procedures and differentiation of species under the supervision of persons experienced in diagnostic parasitology.

The authors wish to thank Miss Jean Ryan for preparing the drawings of the organisms.

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INTRODUCTION

The diagnostic stages of intestinal parasites are differentiated on the basis of specific morphologic features which can be seen microscopically. The characteristics commonly used to distinguish species are presented in tables for the microscopist's ready reference. The descriptions, however, do not include all of the morphologic characteristics of the various stages, and supplemental references may be needed in some cases.

Some of the parasites listed occur only infrequently or accidentally in man; but, since their diagnostic stages may be confused with those of the more common organisms, they have been included here. For example, *Entamoeba polecki* is rarely found in human feces; however, it closely resembles *Entamoeba histolytica* and *Entamoeba coli*, and microscopists unaware of its existence may mistake it for these species. Likewise, several helminth species of lower animals which occasionally parasitize man are included. The diagnostic stages may be misidentified by inexperienced persons. For example, *Trichostrongylus* (Nematode) eggs may be confused with hookworm eggs, and *Hymenolepis diminuta* (Cestode) eggs may be confused with *Hymenolepis nana* eggs.

The protozoa found in the mouth, *Entamoeba gingivalis* and *Trichomonas tenax*, have been omitted, since the diagnostic stages of these parasites are not found in feces. *Trichomonas vaginalis* has not been included, since it is a parasite of the urogenital system rather than of the intestinal tract. Technical methods for examining specimens are presented in the manual "Laboratory Procedures for the Diagnosis of Intestinal Parasites" (Melvin and Brooke, 1969, in press).

The morphology of the intestinal parasites is described in many parasitology textbooks. Some of those which emphasize morphology of the diagnostic stages and have good illustrations are listed in the references.

PROTOZOA

The intestinal protozoa of man belong to four groups: amebae (Sarcodina), flagellates (Mastigophora), ciliates (Ciliata or Infusoria), and coccidia (Sporozoa). With the exception of the coccidia and *Giardia lamblia* (flagellate) which inhabit the small intestine, the protozoa live in the colon.

The coccidia (*Isospora* species) differ from the other protozoan species in being obligatory tissue parasites. The growth stages in the host cells are similar to those of malaria. Oöcysts, occasionally sporocysts, passed in the feces, are the diagnostic stages.

Organisms belonging to the three other groups have two stages, trophozoites and cysts, in their life cycle, except *Dientamoeba fragilis* (ameba) and *Trichomonas hominis* (flagellate), which have only a trophozoite stage. Both trophozoites and cysts are passed in feces and are diagnostic stages.

The features listed in Tables 3-7 are those commonly seen in fecal preparations and used for identifications. Features or structures which are difficult to see or are demonstrated only by special techniques have been omitted. Not all of the characteristics listed, however, can be seen in a single type of preparation. The fecal preparations used to demonstrate protozoa are either wet mounts or permanently stained smears.

Wet mounts may be unstained (saline or formalin) or stained (iodine, buffered methylene blue, Quensel's stain, merthiolate-iodine-formaldehyde [M!F], or other temporary stains). Iodine is primarily a cyst stain and iodine preparations are usually routinely prepared in examining fecal specimens for protozoa. Buffered methylene blue and Quensel's stains are used to stain trophozoites. Others, such as M.I.F., will stain both stages, but they may be less satisfactory for trophozoites than for cysts. Scaled drawings of the intestinal protozoa are presented in Figures 1 and 2.

AMEBAE

The characteristics used to distinguish species of intestinal amebae are as follows:

Trophozoites

Motility—progressive or non-progressive.

Cytoplasm

- Appearance—finely granular, coarsely granular, or vacuolated.
- Inclusions—erythrocytes, bacteria, molds.

Nucleus

- Number present.
- Peripheral chromatin—present or absent. If present, the distribution along the nuclear membrane and the size of the granules are important.
- Karyosome—location and size.

Size

Sizes overlap, but they can be used as a secondary distinguishing feature. Size is the chief criterion for distinguishing *Entamoeba histolytica* from *Entamoeba hartmanni*.

Cysts

Nucleus

Number present

Peripheral chromatin—present or absent. If present, the distribution of the granules along the nuclear membrane is important.

Karyosome—location and size.

Cytoplasm

Chromatoid bodies—present or absent. If present, the shape is important.

Glycogen—appearance.

Size

Sizes overlap, but they can be used as a secondary distinguishing feature. Size is the major criterion for distinguishing *Entamoeba histolytica* from *Entamoeba hartmanni*.

Shape

Shapes vary, but they may be useful as a secondary distinguishing feature.

As stated above, both unstained and stained preparations are necessary to demonstrate all of the features. Table 1 indicates the structures or characteristics that can be seen in different types of preparations.

TABLE 1

CHARACTERISTICS OF INTESTINAL AMEBAE VISIBLE IN DIFFERENT TYPES OF FECAL PREPARATIONS

	Unstained		Temporary Stains		Permanent Stains
Characteristic	Saline	Formalin	Iodine (Cysts)	Buffered Methylene Blue (Trophs)[1]	
Trophozoites					
Motility	+	−		−	−
Cytoplasm					
appearance	+	+		+	+
inclusions (rbc, bacteria)	+	+		+	+
Nucleus	−	+[2]		+	+
Cysts					
Nuclei	−	+	+		+
Chromatoid bodies	+	+	+[3]		+
Glycogen	−	−	+		− (vacuole present)

[1] Quensel's stain may be substituted for buffered methylene blue.

[2] Nuclei of trophozoites are visible in formalin-fixed material, but are usually not sufficiently distinctive for species identification.

[3] Chromatoid bodies are more easily seen in unstained wet mounts than in iodine preparations.

Species identification of trophozoites can rarely be made from single features, such as nucleus or cytoplasm, or from a single organism. Several features and several organisms should be examined. Cysts are less variable and can usually be more easily identified than trophozoites. Tables 2 and 3 list the common morphologic characteristics of the amebae. Drawings of the trophozoite and cyst stages are presented in Figure 1.

FLAGELLATES

Characteristics used to distinguish flagellate species are as follows:

Trophozoites

Motility

Shape

Number of nuclei. The appearance of the nucleus is not commonly used to distinguish species.

Other features such as undulating membrane, sucking disk, and prominent cytostome.

Number and location of flagella. Although the number and location of flagella vary with the species, they are often difficult to see and count. Therefore, the number and location of flagella are not practical diagnostic features for routine identification.

Cysts

Shape

Size

Number of nuclei

Fibrils

As with amebae, not all of the characteristics of flagellates can be seen in a single type of preparation, and both unstained and stained preparations may be necessary. Nuclei are not visible in unstained saline mounts, but they can be seen in formalin-fixed material. Most of the other features can be seen in either saline or formalin unstained mounts. Cyst structures are usually easily seen in iodine preparations. Quensel's and buffered methylene blue solutions, however, do not stain the trophozoites. If fresh feces is available, trophozoites can be readily distinguished by their characteristic motion in saline mounts. Methocel solutions can be used to slow the motion, particularly of *Trichomonas*, for better observation of flagella and undulating membranes. Neutral red dye added to the solution will stain the trophozoites to some extent. Table 2 indicates the structures or characteristics that can be seen in different types of preparations.

Tables 5 and 6 list the diagnostic characteristics of the intestinal flagellates. Drawings of the three more common species are presented in Figure 2.

CILIATE

Only one ciliate species, *Balantidium coli* (Figure 2), parasitizes man. It is also man's largest protozoan parasite, and the trophozoites and cysts are easily detected in saline mounts of fresh feces. The size, shape, and motility of the trophozoites are readily recognized by even beginning parasitology students. Although the cysts are less easily identified, they, too, present few real diagnostic problems. In formalin-fixed feces, the trophozoites may be somewhat distorted, but they are usually recognizable. Formalin does not significantly alter the appearance of the cyst.

Good stained preparations of *B. coli* are difficult to obtain. Most of the structural details, however, can be seen in unstained mounts, and neither temporary nor permanent stains are needed. The organism is so characteristic in appearance that identification is usually made without difficulty. The common diagnostic characteristics are listed in Table 7.

COCCIDIA

The coccidia species of man belong to the genus *Isospora* (Figure 2). The diagnostic stages are often difficult to locate in feces, and they are easily overlooked because of their almost transparent appearance. Correct lighting and careful focusing are essential for detection. Stained preparations are of little or no value in demonstrating the organisms, and unstained wet mounts are generally used. Iodine or M.I.F. mounts may be helpful in some cases. The diagnostic characteristics are listed in Table 7.

The immature oöcysts of *Isospora* species frequently cannot be readily distinguished from immature oöcysts of *Eimeria* species which parasitize lower animals. Occasionally, *Eimeria* may be accidentally ingested with animal tissue and passed out in human feces. Therefore, if the genus of coccidia is in doubt, it is preferable to identify the organisms as "coccidia" and attempt to obtain mature oöcysts for positive identification. This can be done by mixing the feces containing oöcysts with 2% potassium dichromate solution and letting them stand at room temperature for 48 hours or longer. Mature oöcysts of *Eimeria* contain 4 sporocysts with 2 sporozoites; those of *Isospora* contain 2 sporocysts with 4 sporozoites each. See Figure 2 for drawings of the mature oöcyst stages of *Isospora*.

TABLE 2

CHARACTERISTICS OF INTESTINAL FLAGELLATES, CILIATE, AND COCCIDIA

	Unstained		Temporary Stains		Permanent Stains
Characteristic	Saline	Formalin	Iodine (Cysts)	Neutral Red[1] (Trophs)	
Flagellates					
Trophozoites					
Motility	+	−		+	−
Shape	+	+		+	+ (may be distorted)
Nucleus	−	+		+	+
Flagella	±	−		+	±
Other Features[2]	+	+		+	+
Cysts					
Shape	+	+	+		+
Nuclei	−	+	+		+
Fibrils	±	+	+		+
Ciliate (B. coli)					
Trophozoites					
Motility	+	−		+	−
Macronucleus	+	+		+	+
Cilia	+	+		+	+
Cysts					
Macronucleus	+	+	±		+
Coccidia (Isospora)					
Oöcysts	+	+	+		± (usually distorted)

[1] Neutral red dye in methocel solutions.
[2] The undulating membrane of Trichomonas may not be visible in all cases.

HELMINTHS

The common helminth parasites of man belong to three groups: nematodes (roundworms), cestodes (tapeworms), and trematodes (flukes). The diagnostic stages of helminths are more easily identified by most technologists than the diagnostic stages of protozoa. Their distinguishing features are less variable and being larger, they are more readily detected. Although the laboratory occasionally receives adult helminths, especially *Ascaris* and *Enterobius*, diagnosis is usually made from eggs, or in some cases, larvae, or body segments (proglottids).

Characteristics which can be used to separate the various eggs are:

Size

Shape

Stage of development when passed in the feces

Thickness of the egg shell

Color

Presence of structures such as mammillated coat, operculum, spine, or plugs

Helminth eggs and larvae are best seen in unstained wet mounts. Neither temporary nor permanent stains are needed.

NEMATODES

The common diagnostic stage of the nematodes is the egg, except for *Strongyloides stercoralis* in which the first stage, or rhabditiform larva, is the usual diagnostic stage. Occasionally, hookworm larvae may also be present in feces and must be distinguished from those of *Strongyloides*.

The rhabditiform larvae of hookworm and *Strongyloides* can be differentiated by the length of the buccal cavity and by the appearance of the genital primordium. In rare cases, filariform (third stage larvae) may be found in feces or they can be obtained by culturing specimens containing eggs or rhabditiform larvae. Filariform larvae differ from rhabditiform larvae in size and in the appearance of the esophagus. The third stage larva is about twice as long as the first stage larva and lacks the bulbed configuration of the esophagus which is characteristic of the rhabditiform larva. The filariform larvae of *Strongyloides* are distinguished from those of hookworm by the appearance of the tip of the tail and the length of the esophagus. The larvae are presented in Figure 5.

Characteristics of the eggs are listed in Table 8; those of the larvae are described in Table 9. Drawings of the nematode eggs are presented in Figure 3.

Eggs of the nematode species are shed more or less continuously and may be present in every fecal specimen from an infected individual. *Strongyloides* larvae, however, are passed irregularly and will not be found in every specimen.

CESTODES

In certain of the cestodes (*Hymenolepis nana*, *Hymenolepis diminuta*, and *Diphyllobothrium latum*), the egg is the usual diagnostic stage. In other species (*Taenia* and *Dipylidium caninum*), eggs may be present in feces, but the proglottid is the usual diagnostic stage. Except in the case of *D. latum*, the cestode eggs are embryonated when they leave the worm's body. The embryo is a six-hooked, spherical structure called an oncosphere.

D. latum eggs are unsegmented when passed and become embryonated outside of the host. They may resemble the eggs of hookworm, infertile *Ascaris*, or *Paragonimus westermani* and must be distinguished from these species. Occasionally, portions of the strobila (chain of proglottids) are passed, and the species can be identified by the characteristic appearance of the proglottids.

The eggs of *Taenia saginata* and *Taenia solium* are identical, and species identification cannot be made from this stage. When found, they should be reported as "*Taenia* species." The common diagnostic stage, however, is the gravid proglottid rather than the egg. Proglottids, either singly or in short chains, become detached from the strobila and are passed with the feces. *T. saginata* proglottids occasionally migrate out of the anus independent of defecation. Specific identification is based on the number of lateral uterine branches in the gravid proglottid. These can be seen in uncleared segments, but they are more distinct in cleared proglottids. A hand lens or dissecting microscope can be used to observe the structural details. The primary branches from one side of the central uterine stem are counted to distinguish between *T. saginata* and *T. solium*. Less frequently, and usually after treatment, scoleces may be obtained for species identification.

Dipylidium caninum, a cestode parasite of dogs, cats, and occasionally man, is also more frequently diagnosed by finding proglottids rather than eggs in the specimen. The eggs, when found, are usually contained in packets or capsules of 5 to 15 or more eggs. In rare cases, the scolex may be obtained for diagnosis.

The eggs of all six of the intestinal cestode species are described in Table 8. Grand proglottids and scoleces of *T. saginata*, *T. solium*, *D. latum*, and *D. caninum* are described in Tables 10 and 11, respectively. Drawings of the eggs and of gravid proglottids and scoleces are presented in Figures 3 and 5, respectively.

TREMATODES

The diagnostic stage of the trematode species parasitic in man is the egg. The characteristics of the eggs of human species are described in Table 8. The eggs of *Clonorchis*, *Opisthorchis*, *Heterophyes*, and *Metagonimus* closely resemble each other, and for this reason, they are difficult to identify. The characteristics described in Table 6 are not always apparent. The eggs of *Fasciola hepatica* and *Fasciolopsis buski* are also very similar, and it may be difficult to differentiate these species.

The eggs of two of the human trematode parasites are ordinarily passed in urine (*Schistosoma haematobium*) or sputum (*Paragonimus westermani*). Eggs of both, however, are occasionally found in feces.

Since trematode eggs are usually found at irregular intervals in feces, several specimens may need to be examined to demonstrate their presence. Drawings of the eggs are presented in Figure 4.

TABLE 3

DIFFERENTIAL MORPHOLOGY OF PROTOZOA FOUND IN STOOL SPECIMENS OF MAN

AMEBAE-TROPHOZOITES

Species	Size (Diameter or length)	Motility	NUCLEUS		CYTOPLASM		
			Number	Peripheral Chromatin	Karyosomal Chromatin	Appearance	Inclusions
Entamoeba histolytica	10-60μ Usual range, *15-20μ—commensal form. **Over 20μ—invasive form.	Progressive with hyaline, finger-like pseudopods.	1 Not visible in unstained preparations.	Fine granules. Usually evenly distributed and uniform in size.	Small, discrete. Usually centrally located, but occasionally is eccentric.	Finely granular.	Red blood cells occasionally. Non-invasive organisms may contain bacteria.
Entamoeba hartmanni	5-12μ Usual range, 8-10μ.	Usually non-progressive, but may be progressive occasionally.	1 Not visible in unstained preparations.	Similar to E. histolytica.	Small, discrete, often eccentric.	Finely granular.	Bacteria.
Entamoeba coli	15-50μ Usual range, 20-25μ.	Sluggish, non-progressive, with blunt pseudopods.	1 Often visible in unstained preparations.	Coarse granules, irregular in size and distribution.	Large, discrete, usually eccentric.	Coarse, often vacuolated.	Bacteria, yeasts, other materials.
Entamoeba polecki	10-25μ Usual range, 15-20μ.	Usually sluggish, similar to E. coli. Occasionally in diarrheic specimens, motility may be progressive.	1 May be slightly visible in unstained preparations. Occasionally distorted by pressure from vacuoles in cytoplasm.	Usually fine granules evenly distributed. Occasionally, granules may be irregularly arranged. Chromatin sometimes in plaques or crescents.	Small, discrete, eccentric. Occasionally large, diffuse, or irregular.	Coarsely granular, may resemble E. coli. Contains numerous vacuoles.	Bacteria, yeasts.
Endolimax nana	6-12μ Usual range, 8-10μ.	Sluggish, usually non-progressive with blunt pseudopods.	1 Visible occasionally in unstained preparations.	None.	Large, irregularly shaped, blot-like.	Granular, vacuolated.	Bacteria.
Iodamoeba bütschlii	8-20μ Usual range, 12-15μ.	Sluggish, usually non-progressive.	1 Not usually visible in unstained preparations.	None.	Large, usually central. Surrounded by refractile, achromatic granules. These granules are often not distinct even in stained slides.	Coarsely granular, vacuolated.	Bacteria, yeasts, or other material.
Dientamoeba fragilis	5-15μ Usual range, 9-12μ.	Pseudopodia are angular, serrated, or broad lobed and hyaline, almost transparent.	2 (In approximately 20% of organisms only 1 nucleus is present.) Nuclei invisible in unstained preparations.	None.	Large cluster of 4-8 granules.	Finely granular, vacuolated.	Bacteria.

*Commensal form—usually found in asymptomatic or chronic cases; may contain bacteria.

**Invasive form—usually found in acute cases; often contain red blood cells.

TABLE 4

DIFFERENTIAL MORPHOLOGY OF PROTOZOA FOUND IN STOOL SPECIMENS OF MAN

AMEBAE-CYSTS

Species	Size	Shape	NUCLEUS			CYTOPLASM	
			Number	Peripheral Chromatin	Karyosomal Chromatin	Chromatoid Bodies	Glycogen
Entamoeba histolytica	10-20μ Usual range, 12-15μ.	Usually spherical.	4 in mature cyst. Immature cysts with 1 or 2 occasionally seen.	Peripheral chromatin present. Fine, uniform granules, evenly distributed.	Small, discrete, usually centrally located.	Present. Elongate bars with bluntly rounded ends.	Usually diffuse. Concentrated mass often present in young cysts. Stains reddish brown with iodine.
Entamoeba hartmanni	5-10μ Usual range, 6-8μ.	Usually spherical.	4 in mature cyst. Immature cysts with 1 or 2 often seen.	Similar to E. histolytica.	Similar to E. histolytica.	Present. Elongate bars with bluntly rounded ends.	Similar to E. histolytica.
Entamoeba coli	10-35μ Usual range, 15-25μ.	Usually spherical. Occasionally oval, triangular or other shapes.	8 in mature cyst. Occasionally supernucleated cysts with 16 or more are seen. Immature cysts with 2 or more occasionally seen.	Peripheral chromatin present. Coarse granules irregular in size and distribution, but often appear more uniform than in trophozoites.	Large, discrete, usually eccentric but occasionally centrally located.	Present, but less frequently seen than in E. histolytica. Usually splinter-like with pointed ends.	Usually diffuse, but occasionally well defined mass in immature cysts. Stains reddish brown with iodine.
Entamoeba polecki	9-18μ Usual range, 11-15μ.	Spherical or oval.	1 Rarely 2. Occasionally visible in unstained preparations.	Usually fine granules evenly distributed.	Usually small and eccentric.	Present. Many small bodies with angular or pointed ends, or few large ones. May be oval, rod-like or irregular.	Usually small, diffuse masses. Stain reddish brown with iodine. A dark area called "inclusion mass" (possibly concentrated cytoplasm) is often also present. Mass does not stain with iodine.
Endolimax nana	5-10μ Usual range, 6-8μ.	Spherical, ovoidal, or ellipsoidal.	4 in mature cysts. Immature cysts with less than 4 rarely seen.	None.	Large (blot-like), usually central.	Occasionally granules or small oval masses seen, but bodies as seen in Entamoeba spp. are not present.	Usually diffuse. Concentrated mass seen occasionally in young cysts. Stains reddish brown with iodine.
Iodamoeba bütschlii	5-20μ Usual range, 10-12μ.	Ovoidal, ellipsoidal, triangular, or other shapes.	1 in mature cyst.	None.	Large, usually eccentric. Refractile, achromatic granules on one side of karyosome. Indistinct in iodine preparations.	Occasionally granules present, but chromatoid bodies as seen in Entamoeba spp. are not present.	Compact, well-defined mass. Stains dark brown with iodine.

TABLE 5

DIFFERENTIAL MORPHOLOGY OF PROTOZOA FOUND IN STOOL SPECIMENS OF MAN
FLAGELLATES-TROPHOZOITES

Species	Size (Length)	Shape	Motility	Number of Nuclei	Number of Flagella*	Other Features
Trichomonas hominis	8-20μ Usual range, 11-12μ.	Pear-shaped.	Nervous, Jerky.	1 Not visible in unstained mounts.	3-5 anterior. 1 posterior.	Undulating membrane extending length of body.
Chilomastix mesnili	6-24μ Usual range, 10-15μ.	Pear-shaped.	Stiff, rotary.	1 Not visible in unstained mounts.	3 anterior. 1 in cytostome.	Prominent cytostome extending ⅓-½ length of body. Spiral groove across ventral surface.
Giardia lamblia	10-20μ Usual range, 12-15μ.	Pear-shaped.	"Falling leaf."	2 Not visible in unstained mounts.	4 lateral. 2 ventral. 2 caudal.	Sucking disk occupying ½-¾ of ventral surface.
Enteromonas hominis	4-10μ Usual range, 8-9μ.	Oval.	Jerky.	1 Not visible in unstained mounts.	3 anterior. 1 posterior.	One side of body flattened. Posterior flagellum extends free posteriorly or laterally.
Retortamonas intestinalis	4-9μ Usual range, 6-7μ.	Pear-shaped or oval.	Jerky.	1 Not visible in unstained mounts.	1 anterior. 1 posterior.	Prominent cytostome extending approximately ½ length of body.

*Not a practical feature for identification of species in routine fecal examinations.

TABLE 6

DIFFERENTIAL MORPHOLOGY OF PROTOZOA FOUND IN STOOL SPECIMENS OF MAN
FLAGELLATES-CYSTS

Species	Size	Shape	Number of Nuclei	Other Features
Trichomonas hominis	No cyst.			
Chilomastix mesnili	6-10μ Usual range, 8-9μ.	Lemon shape with anterior hyaline knob or "nipple."	1 Not visible in unstained preparations.	Cytostome with supporting fibrils. Usually visible in stained preparation.
Giardia lamblia	8-19μ Usual range, 11-12μ.	Oval or ellipsoidal.	Usually 4. Not distinct in unstained preparations. Usually located at one end.	Fibrils or flagella longitudinally in cyst. Occasionally may be slightly visible in unstained cysts. Deep staining fibers or fibrils may be seen lying laterally or obliquely across fibrils in lower part of cyst. Cytoplasm often retracts from a portion of cell wall.
Enteromonas hominis	6-8μ Usual range, 4-10μ.	Elongate or oval.	1-4, usually 2 lying at opposite ends of cyst. Not visible in unstained mounts.	Resembles E. nana cyst. Fibrils or flagella are usually not seen.
Retortamonas intestinalis	4-7μ Usual range, 4-9μ.	Pear-shaped or slightly lemon-shaped.	1 Not visible in unstained mounts.	Resembles Chilomastix cyst. Shadow outline of cytostoma with supporting fibrils extends above nucleus.

TABLE 7

DIFFERENTIAL MORPHOLOGY OF PROTOZOA FOUND IN STOOL SPECIMENS OF MAN CILIATE AND COCCIDIA

Species	Size (Length)	Shape	Motility	Number of Nuclei	Other Features
Balantidium coli					
Trophozoite	50-70μ or more. Usual range, 40-50μ.	Ovoid with tapering anterior end.	Rotary, boring.	1 large, kidney shaped macronucleus. 1 small subspherical mircronucleus immediately adjacent to macronucleus. Macronucleus occasionally visible in unstained preparation as hyaline mass.	Body surface covered by spiral, longitudinal rows of cilia. Contractile vacuoles are present.
Cyst	45-65μ Usual range, 50-55μ.	Spherical or oval.	———	1 large macronucleus visible in unstained preparations as hyaline mass.	Macronucleus and contractile vacuole are visible in young cysts. In older cysts, internal structure appears granular.
Isospora species (I. belli and I. hominis)	Oöcyst: 25-30μ Usual range, 28-30μ. Immature oöcyst not usually seen in I. hominis.	Ellipsoidal.	Non-motile.		Mature oöcyst contains 2 sporocysts with 4 sporozoites each. I. belli: usual diagnostic stage is immature oöcyst with single granular mass (zygote) within. I. hominis: mature sporocysts, singly or in pairs, are usually passed in feces. Oöcyst wall not apparent.
	Sporocyst: I. belli-12-14μ I. hominis-14-16μ.	Round or oval.			

TABLE 8

DIFFERENTIAL MORPHOLOGY OF THE DIAGNOSTIC STAGES OF HELMINTHS FOUND IN MAN

EGGS

Species	Size	Shape	Color	Stage of Development When Passed	Specific Features and Variations
NEMATODES					
Enterobius vermicularis	55μ x 26μ Usual range, 50-60μ x 20-32μ.	Elongate, asymetrical with one side flattened, other side convex.	Colorless.	Embryonated. Contains C shaped or tadpole-like embryo.	Smooth, thin egg shell with one flattened side. Occasionally may contain fully developed larva. (More readily found on anal swabs than in feces.)
Ascaris lumbricoides fertile egg	60μ x 45μ Usual range, 45-70μ x 35-50μ.	Round, or ovoidal with thick shell.	Brown or yellow brown.	1 cell, separated from the shell at both ends.	Mammillated albuminous coat or covering on outer shell. Covering is occasionally lost and the decorticated eggs have a colorless shell with gray or black internal material. Occasionally, the inner cell may be in various stages of cleavage: 2 cells, 4 cells, etc., or a fully developed larva.
infertile egg	90μ x 40μ Usual range, 85-95μ x 35-45μ.	Elongate, occasionally triangular, kidney-shaped or other bizarre forms. Shell often very thin.	Brown.	Internal material is a mass of irregular globules and granules that fills shell.	Mammillated covering attenuated or missing in many cases.
Trichuris trichiura	54μ x 22μ Usual range, 49-65μ x 20-29μ.	Elongate, barrel-shaped with a polar "plug" at each end.	Yellow to brown. "Plugs" are colorless.	1 cell or unsegmented.	Polar plugs are distinctive. Occasionally are oriented in a vertical or slanted position and may not be readily recognized. A gentle tap on the coverslip will usually reorient the egg. On rare occasions, atypical eggs lacking polar plugs may be seen.
Hookworm Ancylostoma duodenale and Necator americanus	60μ x 40μ Usual range, 57-76μ x 35-47μ. 65μ x 40μ Usual range, 55-79μ x 35-45μ.	Oval or ellipsoidal with a thin shell.	Colorless with greyish cells.	4- to 8-cell stage.	Occasionally, eggs in advanced cleavage (16 or more cells) or even embryonated may be seen. Rhabditiform larvae may be present if the specimens are old. Species identification cannot be made on eggs alone; therefore, eggs should be reported simply as hookworm.
Trichostrongylus species	90μ x 40μ Usual range, 75-95μ x 40-50μ.	Elongate with one (or both) end more pointed than hookworm.	Colorless with greyish cells.	May be in advanced cleavage or morula stage.	Egg resembles hookworm egg but is larger and more pointed at the ends.

TABLE 8

DIFFERENTIAL MORPHOLOGY OF THE DIAGNOSTIC STAGES OF HELMINTHS FOUND IN MAN

EGGS

Species	Size	Shape	Color	Stage of Development When Passed	Specific Features and Variations
CESTODES					
Taenia saginata Taenia solium	35μ Usual range, 31-43μ.	Spherical or sub-spherical with thick striated shell.	Walnut brown.	Embryonated. 6-hooked oncosphere is present inside a thick shell.	Thick, striated shell. Eggs of T. solium and T. saginata are indistinguishable and species identification should be made from proglottids or scoleces. "Taenia" spp. should be reported if only eggs are found.
Hymenolepis nana	47μ x 37μ Usual range, 40-60μ x 30-50μ.	Oval or sub-spherical. Shell consists of 2 distinct membranes. On inner membrane are two small "knobs" or poles from which 4 to 8 filaments arise and spread out between the two membranes.	Colorless, almost transparent.	Embryonated. 6-hooked embryo contained in egg.	Polar filaments.
Hymenolepis diminuta*	72μ Usual range, 70-86μ x 60-80μ.	Round or slightly oval. Striated outer membrane and thin inner membrane with slight poles. Space between membranes may appear smooth or faintly granular.	Yellow.	Embryonated. 6-hooked oncosphere inside shell.	Resembles H. nana but lacks polar filaments. Poles are rudimentary and often hard to see.
Dipylidium caninum*	35-40μ Usual range, 31-50μ x 27-48μ.	Spherical, subspherical or oval. 5-15 eggs (or more) are enclosed in a sac or capsule.	Colorless.	Embryonated.	Eggs are contained in a sac or capsule which ranges in size from 58μ x 45μ to 60μ x 170μ. Occasionally, capsules are ruptured and eggs are free.
Diphyllobothrium latum	66μ x 44μ Usual range, 58-76μ x 40-51μ.	Oval or ellipsoidal with an inconspicuous operculum at one end and a small "knob" at the other end.	Yellow to brown.	Unembryonated. Germinal cell is surrounded by a mass of yolk cells which completely fills inner area of shell. Germinal cell is usually not visible.	Egg resembles hookworm egg but has a thicker shell and an operculum.

*Usually found in lower animals, only occasionally found in man.

TABLE 8

DIFFERENTIAL MORPHOLOGY OF THE DIAGNOSTIC STAGES OF HELMINTHS FOUND IN MAN

EGGS

Species	Size	Shape	Color	Stage of Development When Passed	Specific Features and Variations
TREMATODES					
Schistosoma mansoni	155μ x 66μ Usual range, 114-118μ x 45-73μ.	Elongate with prominent lateral spine near posterior end. Anterior end tapered and slightly curved.	Yellow or yellow brown.	Embryonated. Contains mature miracidium.	Lateral spine. Found in feces; in rare cases, in urine also. Eggs are discharged at irregular intervals and may not be found in every stool specimen. Are rare in chronic stages of the infection.
Schistosoma japonicum	90μ x 70μ Usual range, 68-106μ x 45-80μ.	Oval or subspherical. Small lateral spine is often not seen or may appear as a small hook or "knob" located in a depression in the shell.	Yellow or yellow brown.	Embryonated. Contains mature miracidium.	Found in feces. Often coated with debris and may be overlooked.
Schistosoma haematobium	143μ x 60μ Usual range, 112-170μ x 40-73μ.	Elongate with rounded anterior end and terminal spine at posterior end.	Yellow brown.	Embryonated. Contains mature miracidium.	Terminal spine. Found in urine, occasionally in feces. Egg often covered with debris.
Clonorchis sinensis	30μ x 16μ Usual range, 27-35μ x 11-20μ.	Small, ovoidal or elongate with broad, rounded posterior end and a convex operculum resting on "shoulders." A small "knob" may be seen on the posterior end.	Yellow brown.	Embryonated. Contains mature miracidium.	Small size, operculum and "knob" on posterior end. Shell often is covered by adhering debris.
Opisthorchis felineus	30μ x 12μ. Usual range, 26-30μ x 11-15μ.	Elongate, with operculum on anterior end and pointed terminal "knob" on posterior end.	Yellow brown.	Embryonated. Contains mature miracidium.	Lacks prominent shoulders characteristic of Clonorchis and has more tapered end.

TABLE 8

DIFFERENTIAL MORPHOLOGY OF THE DIAGNOSTIC STAGES OF HELMINTHS FOUND IN MAN

EGGS

Species	Size	Shape	Color	Stage of Development When Passed	Specific Features and Variations
TREMATODES—Cont.					
Heterophyes heterophyes	28μ x 15μ Usual range, 26-30μ x 14-17μ.	Small, elongate or slightly ovoidal. Operculum. Slight "knob" at posterior end.	Yellow brown.	Embryonated. Contains mature miracidium.	Resembles Clonorchis egg but with less distinct shoulders. Operculum is broader than in Clonorchis.
Metagonimus yokogawai	28μ x 17μ Usual range, 26-35μ x 15-20μ.	Small, elongate or ovoidal. Operculum. No "shoulders" at anterior end. Small "knob" often seen on posterior end.	Yellow or yellow brown.	Embryonated. Contains mature miracidium.	Resembles Clonorchis and Heterophyes eggs. Shell is slightly thinner than Heterophyes. Operculum is broader than Clonorchis.
Paragonimus westermani	85μ x 53μ Usual range, 68-118μ x 39-67μ.	Ovoidal or elongate with thick shell. Operculum is slightly flattened and fits into shoulder area of shell. Posterior end is thickened. Egg often asymetrical with one side slightly flattened.	Yellow brown to dark brown.	Unembryonated. Filled with yolk material in which a germinal cell is imbedded. Cells are irregular in size.	Found in sputum, occasionally in feces. Resembles egg of D. latum but is larger, slightly asymetrical and the operculum is smaller and flatter. The widest part of the Paragonimus egg is usually anterior to the center while in D. latum, the widest area is about the center.
Fasciola hepatica	150μ x 80μ Usual range, 120-182μ x 63-102μ.	Ellipsoidal, thin shell. Small, indistinct operculum.	Yellow to light brown.	Unembryonated. Filled with yolk cells in which an indistinct germinal cell is imbedded.	Large size. Broadly oval eggs.
Fasciolopsis buski	140μ x 80μ Usual range, 130-159μ x 78-98μ.	Ellipsoidal, thin shell. Small, indistinct opercuum.	Yellowish brown.	Unembryonated. Filled with yolk cells in which an indistinct germinal cell is imbedded.	Large size. Resembles F. hepatica egg and cannot be easily distinguished from Fasciola.

TABLE 9

DIFFERENTIAL MORPHOLOGY OF THE DIAGNOSTIC STAGES OF HELMINTHS FOUND IN MAN

LARVAE

Species	Rhabditiform Larva (First Stage. Has bulbed esophagus.)			Filariform Larva (Third Stage. Lacks prominent bulb in esophagus.)		
	Size	Genital Primordium	Buccal Cavity	Size	Length of Esophagus	Tip of Tail
Strongyloides stercoralis	225μ x 16μ Usual range, 200-300μ x 16-20μ.	Prominent. Is an elongate, tapered, or pointed structure located along ventral wall about midway the body length.	Short, about $\frac{1}{3}$ to $\frac{1}{2}$ as long as the width of the anterior end of the body.	550μ x 20μ Usual range, 500-550μ x 20-24μ.	Extends approximately $\frac{1}{2}$ length of body.	Notched.
Hookworm	250μ x 17μ Usual range, 200-300μ x 14-17μ.	Inconspicuous. Rarely distinct. When seen, is small, located nearer the tail than that of Strongyloides.	Long. Approximately as long as the width of the body.	500μ. Usual range, 500-700μ x 20-24μ.	Extends about $\frac{1}{4}$ length of body.	Pointed.

TABLE 10
DIFFERENTIAL MORPHOLOGY OF THE DIAGNOSTIC STAGES OF HELMINTHS FOUND IN MAN
TAPEWORM GRAVID PROGLOTTIDS

Species	Size	Appearance of Uterus	Other
Taenia solium	12mm in length x 5-7mm wide.	Central "stem" or trunk with 7-13 main lateral branches on each side.	Usually on surface of fecal material. May be in short chains of 2-3 proglottids.
Taenia saginata	16-20 mm long x 5-7mm wide.	Central "stem" or trunk with 15-20 main lateral branches on each side.	Usually on surface of fecal material. May be single detached proglottids.
Diphyllobothrium latum	2-4mm long x 10-12mm wide. Broader than long.	Coiled into a rosette appearance.	Occasionally, portion of worm may be passed. Egg is usual diagnostic stage.
Dipylidium caninum	12mm long x 3mm wide. Pumpkin-seed shape; tapers at each end.	Consists of capsules filled with eggs.	Proglottids may be passed singly or in chains. Often resemble rice grains in stool.

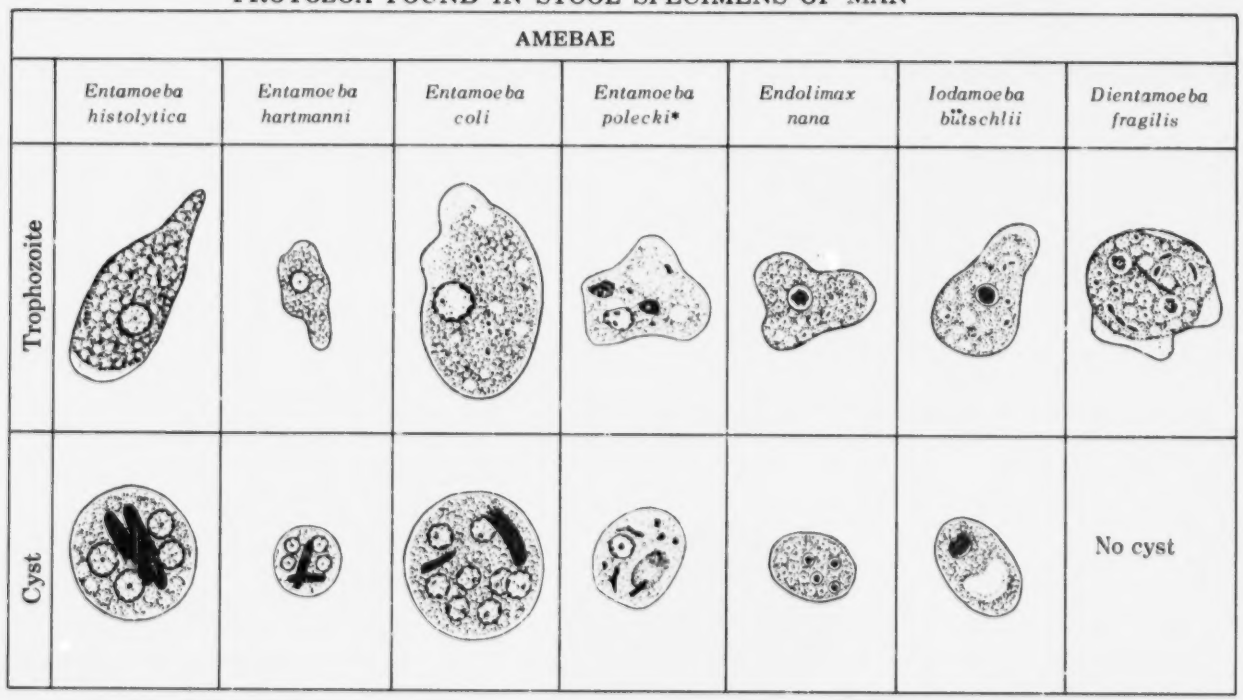
TABLE 11

DIFFERENTIAL MORPHOLOGY OF THE DIAGNOSTIC STAGES OF HELMINTHS FOUND IN MAN
TAPEWORM SCOLECES

Species	Size	Shape	Suckers		Other
			No.	Appearance	
Taenia solium	Approximately 1mm in diameter.	Globular or rounded.	4	Cup-like.	Double row of 25-30 large and small brown chitinous hooks arranged around a rostellum (small projection) at the top of the scolex.
Taenia saginata	1 to 2mm in diameter.	Rounded or slightly pyriform.	4	Cup-like.	Does not have a rostellum or hooks.
Diphyllobothrium latum	2 to 3mm in length x 1mm wide.	Almond-shape or spatulate.	2	Grooves.	Does not have a rostellum or hooks. Deep grooves (suckers) are located dorsally and ventrally on the scolex, but often appear to be lateral.
Dipylidium caninum	0.35 x 0.37mm.	Rhomboid or rounded.	4	Oval, cup-like.	Prominent conical or ovoid rostellum with 30 to 150 small thorn-shaped hooks arranged in several rows (1-7 rows). Rostellum may be retracted into a depression at the upper margin of the scolex.

Figure 1

PROTOZOA FOUND IN STOOL SPECIMENS OF MAN

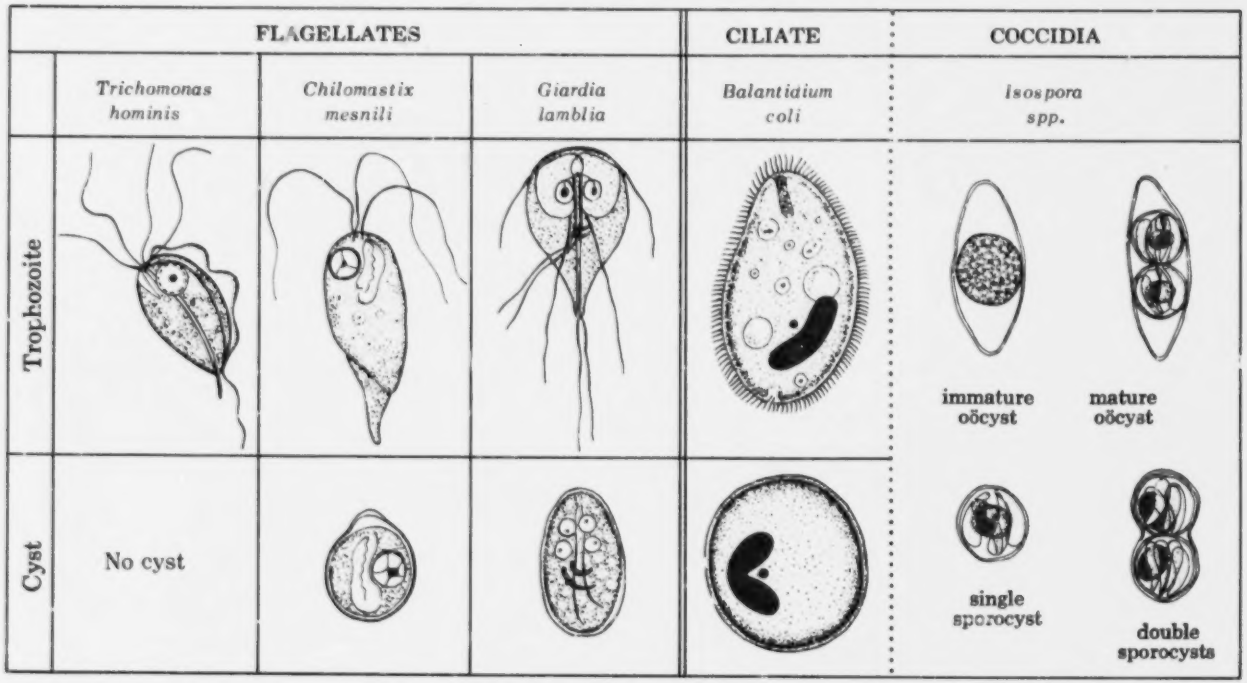


(Adapted from Brooke and Melvin, 1964)

*Rare, probably of animal origin

Figure 2

PROTOZOA FOUND IN STOOL SPECIMENS OF MAN

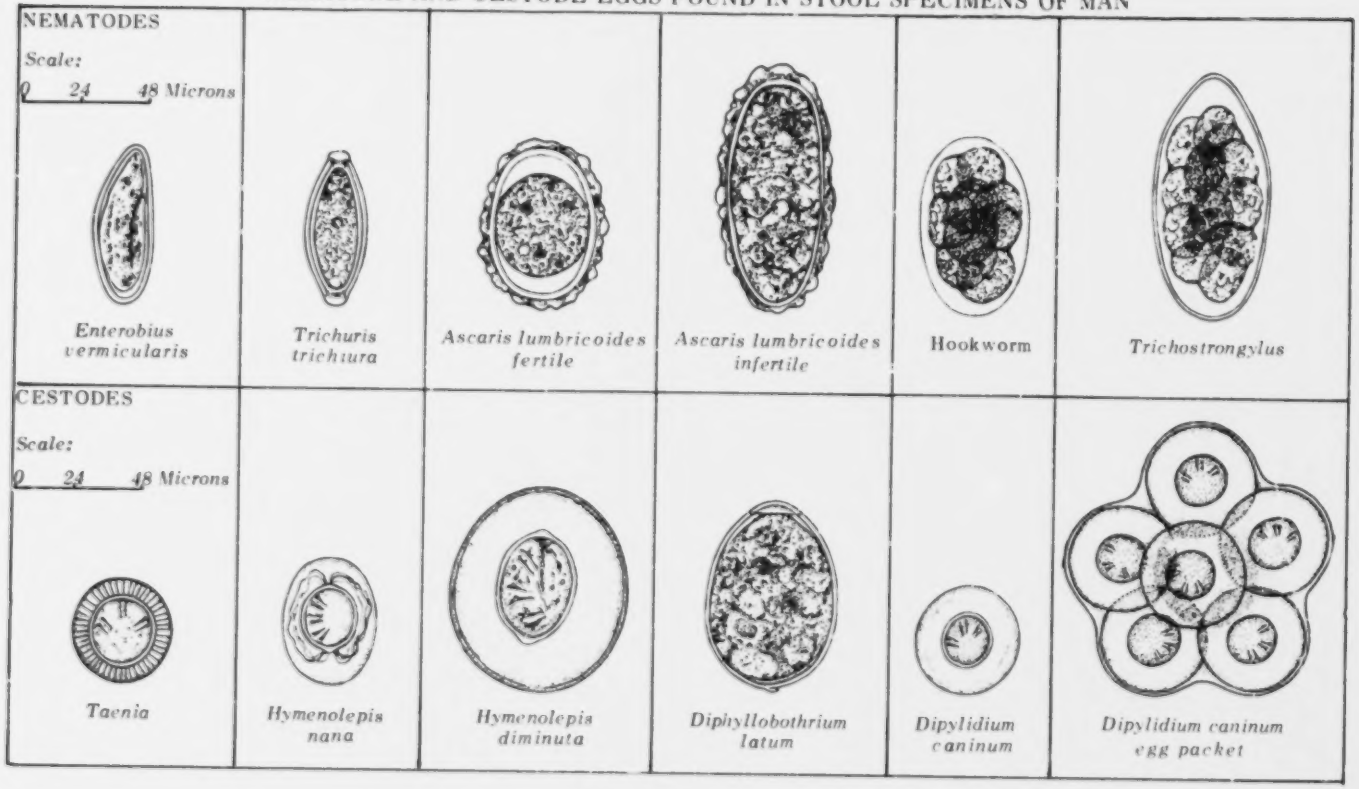


(Adapted from Brooke and Melvin, 1964)

Reproduced from best available copy.

Figure 3

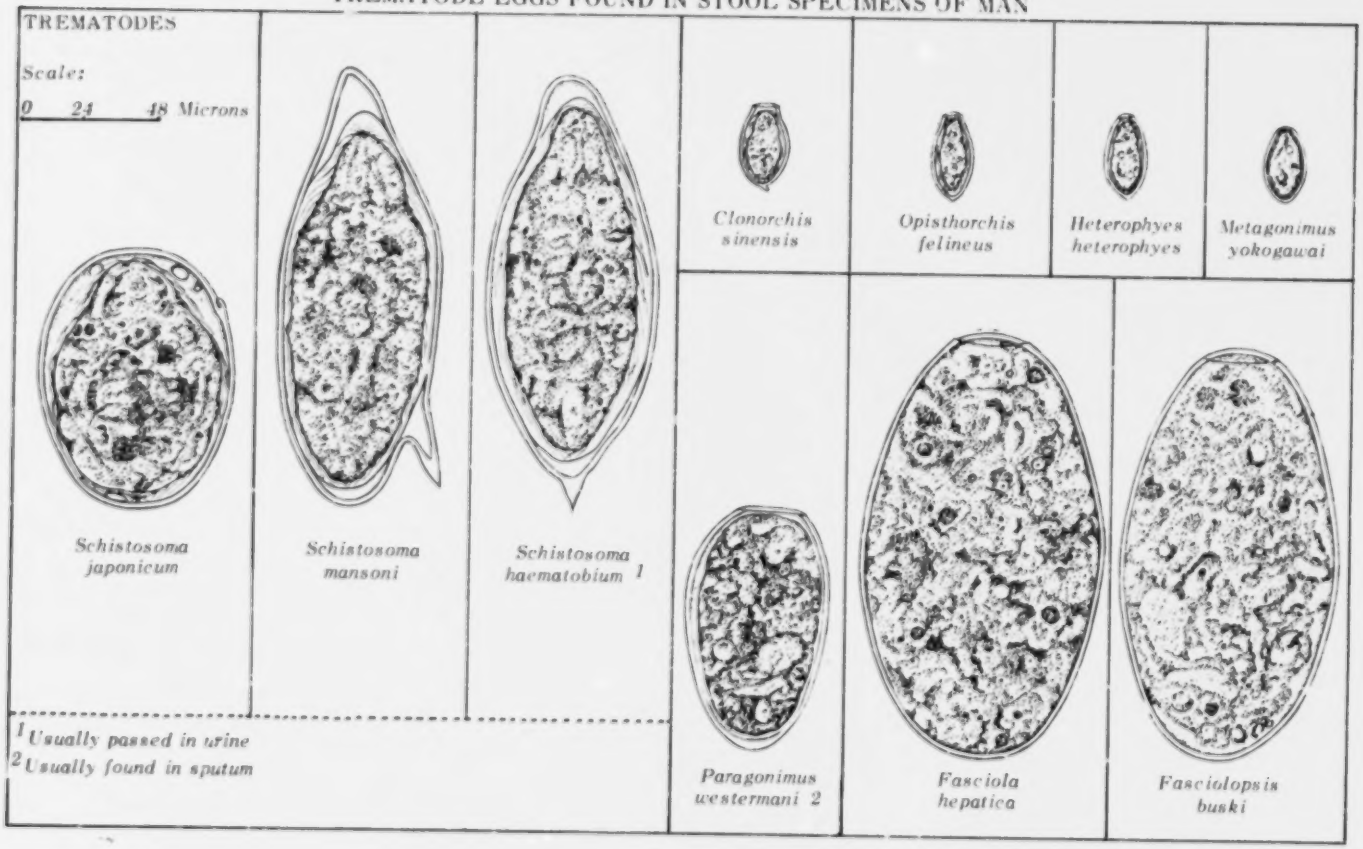
NEMATODE AND CESTODE EGGS FOUND IN STOOL SPECIMENS OF MAN



(Adapted from Melvin, Brooke, and Sadun, 1959)

Figure 4

TREMATODE EGGS FOUND IN STOOL SPECIMENS OF MAN



(Adapted from Melvin, Brooke, and Sadun, 1959)

Figure 5

HOOKWORM AND STRONGYLOIDES LARVAE

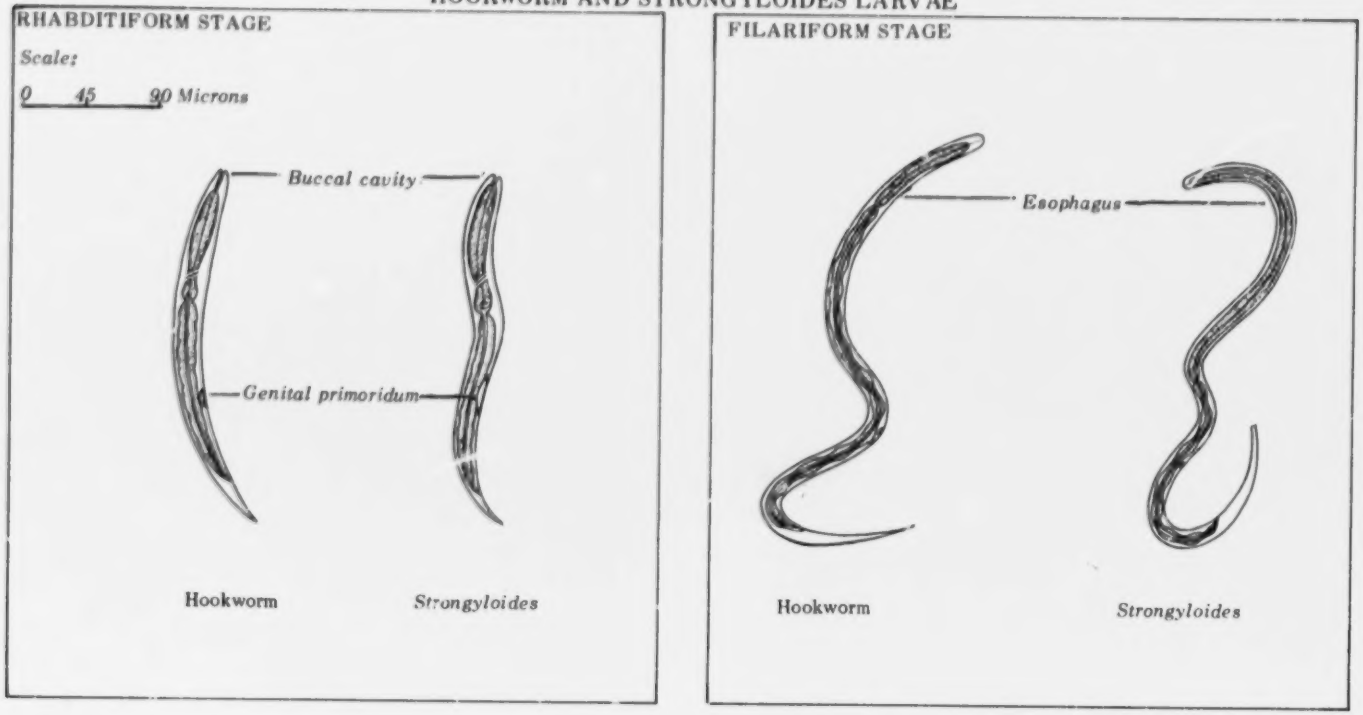
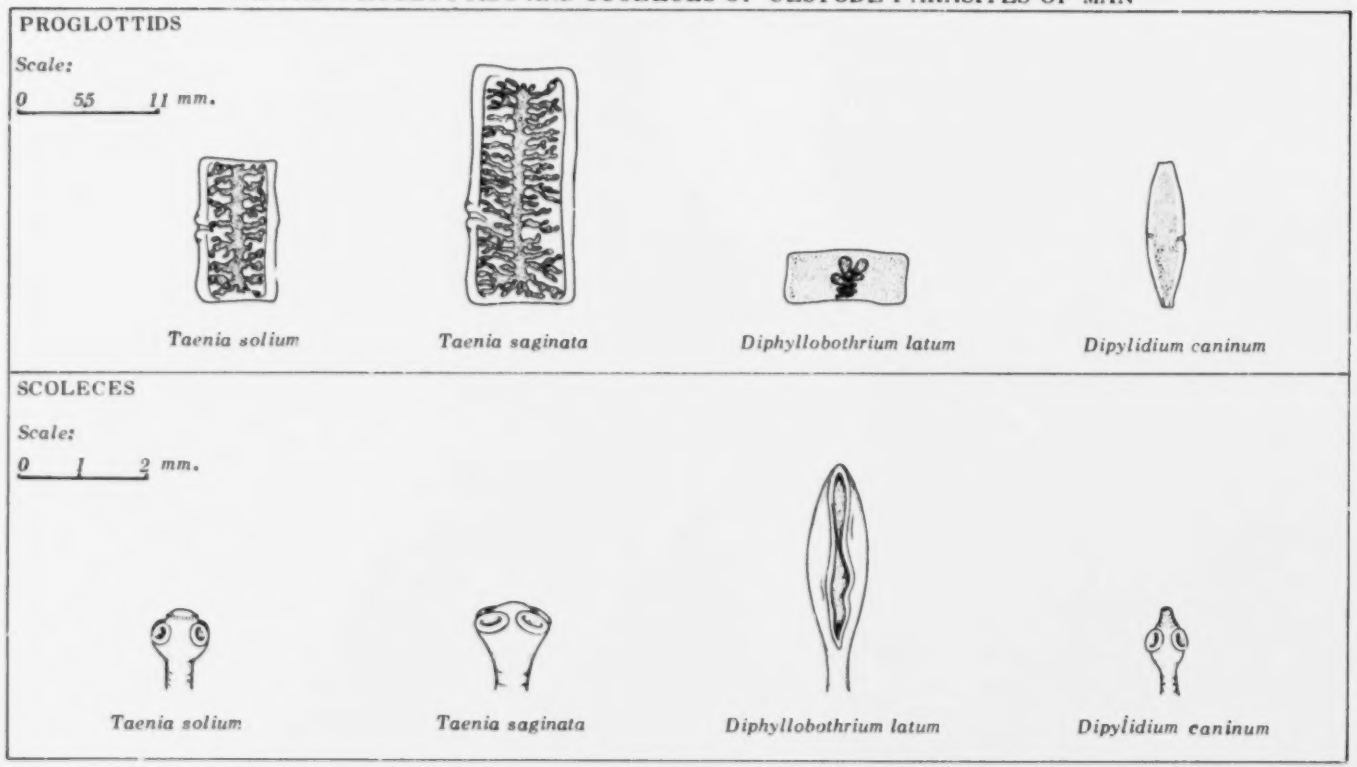


Figure 6

GRAVID PROGLOTTIDS AND SCOLECES OF CESTODE PARASITES OF MAN



REFERENCES

Belding, D. L. 1965. *Textbook of Parasitology.* 3rd ed. Appleton-Century Crofts, New York.

Blacklock, D. C. and Southwell, T. 1966. *A Guide to Human Parasitology for Medical Practitioners.* 8th ed. Williams and Wilkins Co., Baltimore.

Brooke, M. M. and Melvin, D. M. 1964. *Common Intestinal Protozoa of Man, Life Cycle Charts.* PHS Publication No. 1140. Government Printing Office, Supt. of Documents, Washington, D. C. 20402.

Brown, H. W. and Belding, D. L. 1964. *Basic Clinical Parasitology.* 2nd ed. Appleton-Century-Crofts, New York.

Burrows, R. B. 1965. *Microscopical Diagnosis of the Parasites of Man.* Yale University Press, New Haven, Connecticut, and London.

Faust, E. C. and Russell, P. F. 1965. *Craig and Faust's Clinical Parasitology.* 7th ed. Lea and Febiger, Philadelphia.

Faust, E. C., Beaver, P. C., and Jung, R. C. 1968. *Animal Agents and Vectors of Human Disease.* 3rd ed. Lea and Febiger, Philadelphia.

Jeffery, H. C. and Leach, R. M. 1966. *Atlas of Medical Helminthology and Protozoology.* Williams and Wilkins Co., Baltimore.

Markell, E. K. and Voge, M. 1958. *Diagnostic Medical Parasitology.* W. B. Saunders, Philadelphia.

Melvin, D. M., Brooke, M. M., and Sadun, E. H. 1959. *Common Intestinal Helminths, Life Cycle Charts.* PHS Publication No. 1235 (1964). Government Printing Office, Supt. of Documents, Washington, D.C. 20402.

Melvin, D. M. and Brooke, M. M., 1969. *Laboratory Procedures for the Diagnosis of Intestinal Parasites.* (In press. To be published by the Government Printing Office.)

Spencer, F. M. and Monroe, L. S. 1961. *The Color Atlas of Intestinal Parasites.* Charles C. Thomas Co., Springfield, Illinois.

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